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Energy production trend in Iran and its effect on sustainable development

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ABSTRACT

The purpose of this study is to review the energy production trend from different energy resources in recent decades and its effect on sustainable energy production as one of the basic axis of sustainable development in Iran.

Ninety nine percent of energy production in Iran comes from oil & gas and only 1% from renewable energy resources. Since Iran has very rich fossil energy resources, little attention has been paid to explore alternative ways of energy production. Majority of country's income is from oil & gas which put extra pressure on its natural resources. Continuing with the existing trend may lead to a path away from the goals of sustainable development, set for the country. Therefore, the sustainability study should be of interest to decision-makers.

Contents

1. Introduction

The oil industry has been exploited for the past 60 years in Iran. It has been shown that oil and development have direct influence on one another; the fluctuation of oil process, its rise and recession, has a great effect on the nation's developmental trend [1]. Relying solely on nonrenewable energy sources like oil can become a cause of unsustainability by itself.

Iran's population has increased and simultaneously the residency pattern has favored the urban areas in the last decade (Fig. 1). Urbanism increase is an important index of progress in parallel with the production and growth of economy. However, urbanism evolution in Iran is not the result of social and economic streamlining, rather the intensification of the gap of the expected incomes between urban and rural areas, seasonal drought and the availability of the resources. However, energy is essential for socioeconomic progress in developing countries, and the demand for energy will increase with population. The policy objectives underlying the definition of sustainability were to ensure compatibility between economic growth and efficient and secure energy supplies together with a clean environment.

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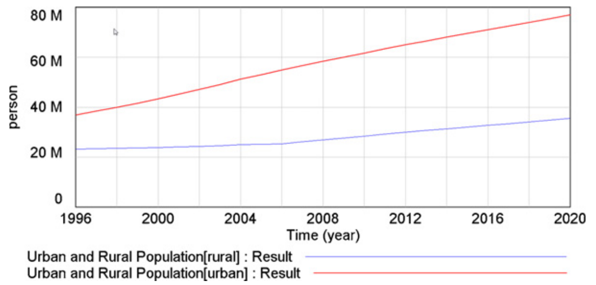


Fig. 1. Rural and urban population differences.

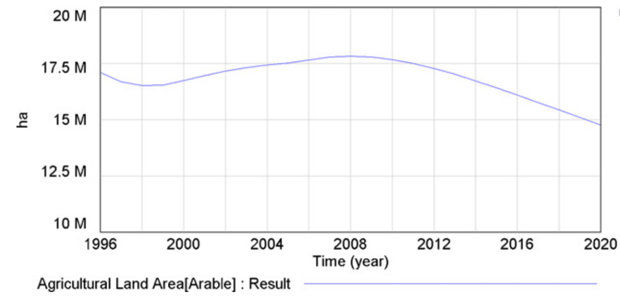


Fig. 2. Agricultural lands area.

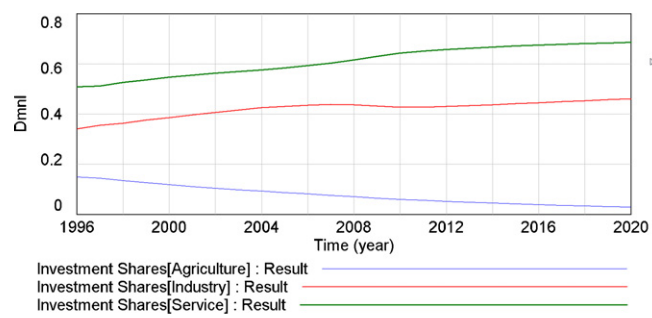


Fig. 3. Relative investment in different economic parts.

The purpose of this study is to review the energy production trend from different energy resources in recent decades and its effect on energy production sustainability.

2. Methodology

The abstract model development stages, model formulation and model stimulation in dynamic system format was utilized for this study. In this prototype, the basic math forms applied for model variables calculation by using VENSIM DSS modeling language (5.10b version). In these equations *g*, *h*, and *f* are arbitrary, non-linear, potentially time varying, vector-valued functions. Eq. (1) represents the evolution of the system over time; Eq. (2) is the computation of the rates determining that evolution. The intermediate results necessary to compute the rates is depicted in Eq. (3), and Eq. (4) shows the initialization of the system.

$$LevelS_t = \int_0^t RateS_t \cdot d_t \tag{1}$$

$$RateS_t = g(LevelS_t, aux_t, data_t, const) \tag{2}$$

$$aux_t = f(LevelS_t, aux_t, data_t, const) \tag{3}$$

$$LevelS_0 = h(LevelS_0, aux_0, data_0, const) \tag{4}$$

In order to evaluate sustainable development pattern, the model variables are divide into three main sub-models: economic, social and environmental. The Initial time considered for model stimulation was 1996, based on the census report that is conducted every 10 years, and the last available report was 1986, and the anticipated final time will be 2020.

3. Population & production

Demographic changes are very important in programs and policies related to the environment. The acceleration of urban development and cluster occupancy in metropolitan areas of Iran without pertinent yield can cause essential problems in providing consumer needs. These changes can ultimately destroy the farmlands in rural areas in favor of residential sector.

Reductions in availability of agricultural lands (Fig. 2), relative labor reduction and even reduction in investment in agriculture compared to other economical branches has influenced the progress and production in this field (Fig. 3). Therefore, to overcome this loss, other resources should be deployed.

There seems to be a growing trend to transfer from traditional biomass consumption to fossil fuels as a result of the biomass

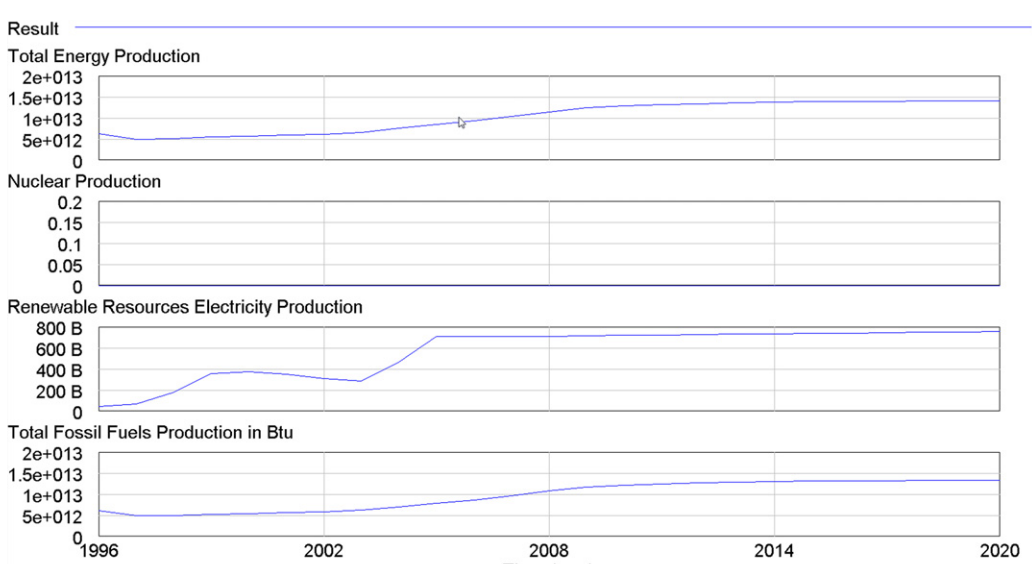


Fig. 4. Different energies production trend.

Table 1
Power production supply from hydropower powerhouses of Iran (1997–2008) (million barrels of oil equivalent).

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Hydropower	4.12	2.91	2.15	2.97	4.73	6.52	6.25	9.46	10.68	10.58	2.79

resources decrease and urbanization by rural migrations. The absence of some law reinforcement, such as taxing the amount of CO_2 production as an environmental pollutant, causes the increase of the fossil fuel consumption rather than effective use of other sources of clean energy.

Iran, as a developing country with unimpressive success in agricultural and industrial parts as the essential pillar in production, is also home to many natural resources such as gas and oil. Oil & gas as the basic energy supply and income is crucial to economic growth of Iran, but it should be emphasized that this is a nonrenewable resource.

4. Energy production in Iran

Energy sustainable evolution is one of the most important prerequisites for environmental development. Renewable energy technologies and energy conservation are two solutions for energy sustainable development [3]. The potential use of different energy resources whether nonrenewable such as fossil resource or renewable energies such as wind power, solar, thermal, geothermal, photovoltaic, biomass, biogas, hydrogen energy and fuel cell exist in Iran.

4.1. Fossil energy

Ninety nine percent of energy production in Iran is from oil & gas and less than 1% is obtained from wind, solar and water. Studying the process of energy manufacturing shows that the production portion of the renewable energies is still under 1%, although this portion has increased over the recent decade. Furthermore, over 50% of crude oil production and petroleum products export, forces the economy to rely on natural resources (Figs. 4 and 5).

4.2. Hydropower energy

Hydropower energy is considered the most important energy production resource of renewable kind in Iran and has the most production portion in clean energies. Table 1 shows the production between 1998 and 2008 which has had intensive changes over this period. The main causes of this unfortunate decline could have been drought, inefficient production method and equipment availability.

4.3. Solar energy

Considering that there is an average of 300 sunny days per year in Iran [2], the country has a high potential for energy production

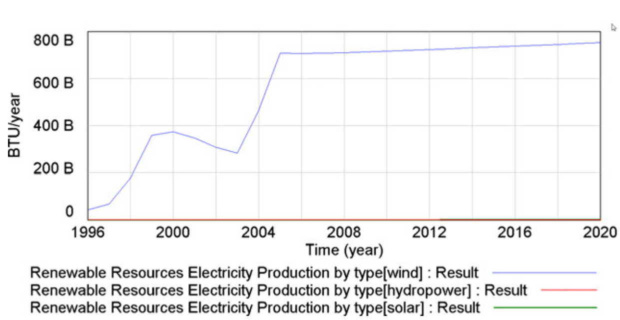


Fig. 5. Energy production from renewable resources.

Table 2
Electricity production supply from photovoltaic sites of Iran (1998–2008) (kWh).

Year	Semnan site	Taleghan site	Yazd site	Total
1998	21 000	–	–	21 000
1999	20 000	–	–	20 000
2000	73 000	–	12 400	85 400
2001	96 000	–	14 100	110 100
2002	14 500	22 000	11 100	47 600
2003	63 450	45 000	10 800	119 250
2004	83 300	45 000	8900	37 200
2005	25 000	10 000	18 000	53 000
2006	20 000	42 000	17 000	79 000
2007	24 000	32 000	15 000	71 000
2008	21 000	38 000	15 000	74 000

from photovoltaic powerhouses. Table 2 shows the energy production of photovoltaic sites between 1998 and 2008. The electricity production trend study shows 13% growth in 11 years and in 2008 the electricity production amount was equivalent to 44 barrels of oil.

4.4. Wind power

The electricity production amount from Wind power plant between 1998 and 2008 is depicted in Table 3. In 2008 electricity production from wind turbine was equivalent to 0.12 million barrels of oil. The study of electricity production trend shows 27% growth in 11 years [4].

4.5. Biofuel

The use of alternative fuels such as biodiesel and ethanol as reasonable and effective strategies towards achieving the sustainable development goals has been proposed to transportation department. However, the present production capacity of ethanol in Iran is 0.7 million liter per day [4] and it is only at the level of academic research.

4.6. Geo-thermal energy

Iran is a developing country with growing rate of electricity consumption, and in order to supply an estimated rate of 3000 MW/year demand securely, a renewable energy source, in general and geothermal energy in particular, should become available to help the sustainable development of the country [5].

Table 3
Electricity production from wind power plant of Iran (1998–2008).

Year	No. of turbines	Nominal capacity (kW)	Specific production (GWh)
1998	25	9900	17.59
1999	28	10 800	35.04
2000	28	10 800	36.54
2001	28	10 800	33.66
2002	29	11 400	30.28
2003	43	16 850	27.62
2004	56	24 880	46.1
2005	77	47 580	69
2006	110	58 810	86
2007	133	73 990	143.4
2008	155	90 220	196.27

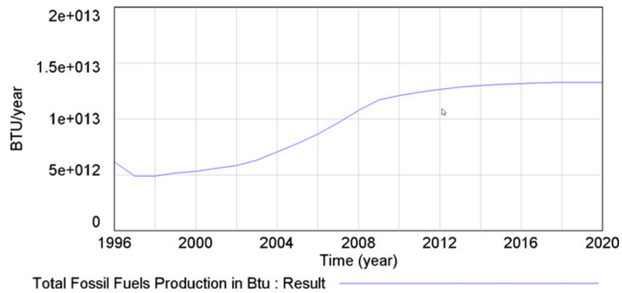


Fig. 6. Total fossil fuel production in Btu.

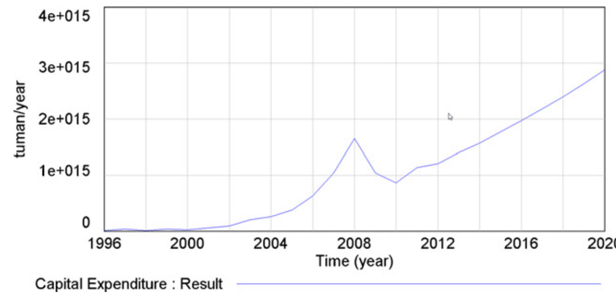


Fig. 7. Capital expenditure.

During recent years (2000 to present) great attention has been directed at generating power from geothermal energy. The installation of the geothermal powerhouse of Meshkinshahr by Energy Affairs Deputy of Power Ministry with the production capacity of 40 (GWh) that will be operational in 2013 has been the first step. The authors believe that direct utilization of thermal waters will provide a tangible flow of income to the remote areas as an additional benefit [6].

5. Energy & development

Production and the rate of access to the renewable and nonrenewable natural energy resources influence the economic and environmental sustainability. Therefore, relying on one kind of energy, namely a nonrenewable source will bring a weak and one-dimensional economy, a sick environment and unorganized society. A weak economy in terms of resources will lead to permanent poverty of that country [7]. In addition, because of the decrease in both private and government investments in other economic divisions, there will be an increase in unemployment, lack of choosing a career and ultimately leads to the migration of intellectuals.

By studying the long-term trend of energy production from fossil resources, it is anticipated that in 2019 energy production from fossil resources will have a decreasing trend and it will go towards the end of fossil fuel resources in Iran (Fig. 6). Therefore, to fulfill the definition of sustainable development, "meet the needs of present without compromising the ability of future generations to meet their own needs" [8], one must start with the modification of present habits.

It is clear that if this pattern of using fossil energy continues, in short time the resource will be completely depleted and this will create a dilemma. Considering Iran is bound and dependent on the oil revenue, once this nonrenewable energy reserve is lost completely, is it still possible to proceed on route to progress and development?

Development can be defined as the process of natural resources being replaced with artificial capitals that transpire under the pressure of population growth. This replacement will be eased by technology and fundamental innovations [9]. Thus rapid decreasing or finishing the natural resources should not be the cause of unsustainable development in Iran, once the natural resources substitution with artificial capitals occurs.

By reviewing Iran's production quota it is disclosed that production has been increased. Still, the question remains if the natural investment resources have changed to artificial investment goods or not? Probing the capital goods trend in Iran, confirms that manufactured financing has flourished (Fig. 7). Concerns remain whether the ratio of this replacement was uniform? Were the goods values comparable? Is their production life equal to their persistence? Or has there been an unequal exchange with natural resources? If the answer to these dilemmas is affirmative, then a sustainable future is not attainable.

In countries with high revenues due to oil as their resource, economic growth relies on government's support through three channels: grants, non-grants activities and venture capitalist and sometimes government regulations can interfere with economic activity.

Studies show that oil revenue over the same period of economic growth has a positive effect, but after a while the economic growth declines, because it depends on natural resources and is not originated from the internal economic mechanism. Also among the government costs, the relationship between the construction costs and economic growth is positive and the relationship between the current costs of the government has different effects on economic growth.

The results reveal that there is a meaningful correlation between the current government costs in human capital affairs and growth. On the contrary, there is an inverse relationship between the current government costs with other ventures and economic growth. The optimized amount of current government costs in other affairs is about 15.01% by GDP [10]. As shown in Fig. 8, this proportion is more optimized from 2004 to 2010 and in 1997.

6. Policies for energy supply

What nowadays is being considered as oil & gas reserves for the Middle East countries including Iran, can act as a practical threat in the long-term. By relying on this unsustainable energy and monetary gains, tremendous planning for their future is being contemplated. Therefore, by increasing the incomes and the possibility of more varied consumptions in Iran, it is expected that economic development and diversity of supply and monopoly power increase go away. It is striking that because of the existence of an easy income resource, collective wisdom of such countries does not take the needs of production in other economic sections serious and vital. There is a superficial sense of security and it is assumed that the oil reserve should counteract the losses. Unfortunately, instead of using the oil reserve as a means to reach sustainable

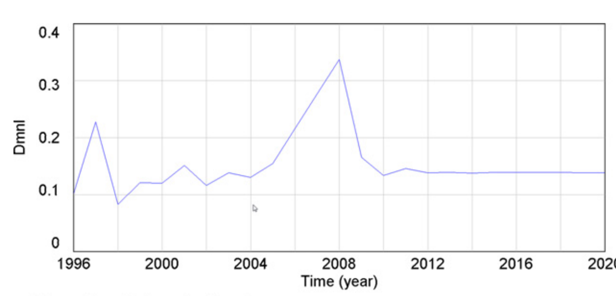


Fig. 8. Expenditure sharing GDP.

development, all efforts are being directed towards its production, which in return causes instability in other economical sectors.

With the false assumption of steady income resources, topics like decision-making responsibility, production and consumption, efficiency increase and implementing new energy resources, etc. are not considered as priorities to be discussed. From an economic point of view, creation and utilization of renewable energy powerhouses in countries that have cheap and abundant fossil energy resources may not seem beneficial, because their production equals, and might even, exceeds their export and in-country demands. Considering the production cost of nonrenewable energy resources, such as oil, is more than the cost of the investment, extraction, transportation, etc. utilizing the other energy resources, especially renewable energies, can guide the consistency and sustainability of production.

It should be pointed out that the mere knowledge of exploiting the renewable energies does not guarantee the cost adjustment. It will be inaccurate to assume that the renewable energies costs are declining and the production costs of nonrenewable ones are increasing. As a matter of fact, the price of both is increasing but the rate of fossil fuels cost is more in comparison to the cost of the nonrenewable energies.

For example, reports [11] show that energy production cost in Europe has increased between 2005 and 2008, due to the increase cost of raw material in addition to population growth, decrease in available production resources and developing demand of the population.

By instituting the following policies, the aforementioned problems could be vanished and proceed towards a stable energy production system:

- Effective investment on renewable energy production
- Assign subsidies for private section in order to transfer investment and decision making from the government towards the private section to produce and consume the renewable energies
- increase local energy supply and demand market portion, instead of cross-country networks
- The decrease investment portion resulted from nonrenewable natural resources in the government budget
- Increase energy supply efficiency
- Considering costs resulted from nonrenewable energy resources, such as oil, endings in their production costs

7. Conclusion

The field of utilizing renewable energies, such as biofuels, geothermal, tidal energy and the waves, is still very immature and at the institutional and academic research level. Nonetheless, with generating changes and establishing policies, operating at practical level can be at reach.

The authors' propose to take advantage of the oil & gas energy resources, and provide more investments in producing renewable energy.

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